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from Wall-Paper and Fabrics.*

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REPRINTED FROM THE BOSTON MEDICAL AND SURGICAL JOURNAL
OF MAY 1, 1890.

BOSTON:
DAMRELL & UPHAM, PUBLISHERS,
Old Corner Bookstore.
1890.



THE FREQUENCY WITH WHICH ARSENIC IS
FOUND IN THE URINE; WITH NOTES ON
SOME NEW CASES OF POISONING FROM
WALL-PAPER AND FABRICS.¹

BY JAMES J. PUTNAM, M.D.

NEARLY a year ago² I reported before this Society, twenty-five cases, hitherto unpublished, of patients under the care of physicians in this vicinity, in whose urine arsenic had been found, which, as a rule, seemed traceable to arsenical wall-papers and fabrics. In most of the cases, the analysis of the urine had been suggested by symptoms more or less characteristic of arsenical poisoning, but in others, the symptoms were not such as would have been called characteristic, and the examination had been made chiefly as a matter of precaution.

Fabrics and wall-papers containing arsenic are so common in this community, if not elsewhere, that I was next led to inquire whether these cases might not indicate the wide-spread dissemination of small quantities of arsenic in a form suitable for ready absorption, and with this view I asked Dr. C. P. Worcester to undertake the analysis of a large number of urines collected in a routine manner.

The persons from whom the specimens were taken, were mainly patients presenting themselves at the Out-patient Department of the Massachusetts General Hospital, those cases being selected, as a rule, that did not exhibit any symptoms that seemed referable to arsenic poisoning. For valuable assistance in the labor of collecting and dispatching the specimens, I owe my thanks to Dr. H. C. Baldwin and Dr. C. F. Carter.

The number of specimens already examined is forty-eight, and in twenty-one of these traces of arsenic were found.

This result seems to me one of decided interest, apart from its clinical importance, to which I shall presently refer.

The fact to which I have repeatedly called attention, that lead is to be found with great frequency in the tissues of healthy persons, is for two reasons, less surprising than that the same should be true of arsenic; first, because lead is less easily eliminated than arsenic, so that it may accumulate little by little; second,

¹ Read before the Boston Society for Medical Improvement, March 10, 1890.

² Boston Medical and Surgical Journal, 1889, i, p. 235.

because the sources of possible lead contamination are extremely numerous.³

The sources of arsenical contamination, on the other hand, are very few. The coloring matter of wall-papers, and of cotton or woollen stuffs constitutes by far the most important of them, and even if, in estimating the significance of the figures that I have given, we make large allowances for coincidence and for exceptional causes, it is impossible to avoid the conclusion that these materials are the breeding ground of arsenical compounds, mainly, perhaps, in the form of vapors, on a considerable scale.

The clinical inference which the figures primarily suggest, is that while these coloring matters are evidently a source of arsenical contamination of the tissues, they are not a frequent cause of poisoning, and that the discovery of arsenic in the urine cannot be taken as a conclusive proof, or even as very strong evidence, taken by itself, as to the origin of doubtful symptoms.

On the other hand, if the results of these forty-eight analyses are anything like typical of those which would be obtained from a larger number, it is evident that the danger, such as it is, is a wide-spread one, and that if even a very small proportion of the persons in whose urine arsenic could be found should be injuriously affected, the absolute number might be quite large.

Every one must admit that it seems chimerical to suppose, *a priori*, that these minute quantities of arsenic could be injurious, considering that much larger amounts are given therapeutically, and taken by arsenic eaters, with immunity and even benefit.

This conservative feeling should only yield to a large amount of circumstantial evidence; but before the evidence already furnished is rejected as insufficient, the following considerations should be allowed full weight:

(1) Although it is possible to accustom one's self to large doses of arsenic, yet it is not uncommon to see very small doses prove highly injurious in the absence of such habituation.

³ The question whether arsenic and lead are constant ingredients of the tissues has repeatedly been the subject of chemico-legal inquiry. Devergie thought this was the case with regard to lead, but it has been disproved for both metals.

The analysis of urine for arsenic is, fortunately, easier than that for lead, and the result more certain.

As a result of recent and very careful investigations, Dr. C. P. Worcester thinks that the indication of the presence of lead under the method by which the earlier analyses reported by me were made, is sometimes capable of being interpreted wrongly, and he, therefore, recommends carrying the process one stage further, as will be shown elsewhere. Nevertheless, in a new series of about fifty routine analyses, lead has been found in twenty-five per cent.

(2) Habituation is ordinarily attained by a gradual and systematic increase of dose, whereas, in many cases, the exposure to arsenical wall-papers and the like is eminently intermittent, and, further, the amount of arsenic given off is apt to vary greatly in consequence of variations in the heat and moisture of the air, and other conditions.

(3) The poisonousness of arsenic, as of many other substances, varies with the preparation, and there is reason to think that the compounds given off from wall-papers are of volatile character, and sometimes of the nature of the highly poisonous "arsines," formed through the agency of the organic substances contained in the paper and glue.

(4) It is very common to hear it said that although a paper which contains what the chemists call "a large quantity" of arsenic might be considered dangerous, yet the same cannot be said of the papers which contain "small quantities," and which are usually reported upon as "harmless."

I would, however, submit, and I think most chemists would agree with me, that in making such a report as this the chemist gives two opinions, only one of which really lies within his competence; the question whether a paper containing any given quantity of arsenic is harmless, being one which can be answered only by clinical experience.

As a matter of fact, even the larger quantities would be considered as small, had they not been shown by experience to be harmful.

There is nothing more striking in the clinical history of this matter than the fact that a person who has once been poisoned, or who is naturally susceptible, is sometimes affected by exposures that seem absurdly insignificant. (See Cases IV and V.)

Again, the size, ventilation, and heating of the room; the character of the paper; the age, susceptibility, and habits of the persons who are to occupy it; and, doubtless, other factors of which we are still ignorant, may have just as much to do with the determination of the question of the degree of the harmfulness of the paper as the amount of arsenic which it contains to the square metre.

It is not in the case of arsenic alone, but of many other substances as well, that susceptibilities differ at the outset, or are increased by an overdose. Both facts, for example, are notably true with regard to tobacco.

In five of the cases where arsenic was found, the urine was analyzed also for lead, and in two cases it was found. I believe this to be important, because it is possible, though the fact is still unproved, that lead

and arsenic, the action of which on the tissues is in many respects so similar, may reinforce each other's poisonous effects, just as lead and alcohol are well known to do.

The main purpose of this paper is reached in the report of the urine analyses, but I will briefly speak of a few important and typical cases of probable poisoning, to which, in the course of the investigation, my attention has been called.

CASE I. The first case appears to be one of a slight degree of generalized neuritis, which passed gradually away after removal of the patient from exposure. The patient was a man of ruddy complexion, and had a general appearance of health, and this is noteworthy in connection with the fact which has been referred to by Kirschgasser and other writers, that persons who are exhibiting some of the poisonous effects of arsenic may, at the same time, show a positive improvement in general nutrition, such as is regarded as among the therapeutical effects of the drug.

The symptoms consisted mainly of pains in the arms, shooting up and down, but felt chiefly between the elbow and shoulder, and to some extent, also, in the fingers and wrists.

There were similar pains in the thighs, and, to a less degree, in the legs below the knees. These pains were worse at night, and occasionally, though rarely, kept the patient awake. At times he had a feeling of numbness in the thumb of the left hand, which he described by saying that it felt as if the blood was squeezed into the end of the thumb. Sensation seemed to be somewhat blunted. There was also slight muscular twitching here and there, though not enough to move the limb. All these symptoms were exaggerated by fatigue.

His illness had begun about nine months before; the first sign consisting in a sense of prickling and numbness in the hands and arms. He had had some conjunctival irritation, though not more than during the last ten or fifteen years. The physical examination showed a stout, healthy-looking man of ruddy complexion. The only physical sign of note was a marked exaggeration of the knee-jerk, without ankle-clonus.

Eight months later the patient reported that he was better for a time, under the tonic treatment which I had given him; but that lately his legs had been feeling weak and tired. The prickling sensation had been less, but he had a sensation of burning on the dorsum of the feet.

At about this period I had the wall-paper of the room in which he lived, examined for arsenic, and

found it to be present in considerable quantity. The urine was analysed for both lead and arsenic. Lead was found in traces, and arsenic in more considerable quantities.

The patient left his room, and has been steadily improving. He was last seen by me a few days ago, and then reported that his former symptoms only troubled him when he was fatigued.

CASE II. The next case is one of apparent poisoning of the skin of the face from arsenic in the covering of a reclining-chair.

The patient was a young lady of nineteen, who had been subject to general eczema from her birth. Her face had at times been a little scaly, but had never presented anything like the attack now to be described, which occurred in January of the present year.

This consisted in the acute outbreak of an eruption covering the entire face, and eventually occupying, also, the external ear and the skin behind the ear, but not encroaching at all on the hairy scalp. The eruption was primarily vesicular in character, and on the subsidence of the vesicles, a hard yellowish scab, was left behind, not scaly, and not surrounded by redness or inflammation to any great extent. This scab was level with the skin, and could not be removed from it, showing that the process had caused localized destruction of tissue. The entire duration of the attack, including an exacerbation, which occurred after a return from a few days visit elsewhere, was about five weeks. At this time, analysis of all articles in the room which could possibly be suspected, were made for arsenic, and it was found to be present in large quantity in the covering of a reclining-chair which she had been using for about two months previous to her attack. Two specimens of urine were examined for arsenic and it was found in both. She improved rapidly after removal of the chair.

CASE III. The third case is one of progressive spastic paraplegia, occurring in a lady of forty-five, of rather delicate constitution. Arsenic was found in the urine on two occasions separated by an interval of several months, the last time only in a very small amount. Arsenic was also found in the wall-paper in a considerable quantity. I am by no means prepared to diagnosticate the case as one of arsenical poisoning, especially as I have seen this form of spinal sclerosis quite a number of times in women, associated with impaired health, or perhaps, as a sign of constitutional weakness. Nevertheless, I think it proper to put the case on record, because I have met with several of like character where lead was found in the

urine, and I think that these poisons may have a contributive effect in causing the disease. It is also worthy of note, that, in this case, traces of albumen and hyaline casts were found in the urine, a condition of which arsenic is well-known to be occasionally the cause. The urine was analysed for lead, but none was found.

CASE IV. The fourth case did not occur in my own practice, but was communicated to me by a colleague, by whom it was closely observed. Although the diagnosis of arsenic poisoning is not positively made out, there is no other, which, reasoning by exclusion, appears so probable. The amount of arsenic found in the wall-paper was but small, but with regard to this point the considerations to which I have called attention above, should be duly weighed.

The patient was an infant, who, at the time of the beginning of her illness, was eight months and three weeks old. The mother had enjoyed perfect good health during gestation, and the child was normal in all respects, at birth, and weighed eight pounds. It was nursed by the mother for two months, and then put on sterilized milk, prepared as recommended by Dr. T. M. Rotch, on which it flourished and gained its proper proportion of weight daily and weekly, becoming an unusually strong, large, muscular and rosy baby, as it continued to be up to the beginning of its illness.

Two months previous to the illness, the family moved to a hired house in the neighboring town. The first symptom, which occurred toward the end of August, 1888, consisted in slight paleness, which was attributed to teething, as this was going on at the time.

During the early part of September, the pallor became more marked, but nothing else was noticed. On the 12th of September, a severe storm confined the child to the house for three days. At the end of that time the pallor had become profound, and was especially noticeable on the lips and finger-tips. The child fretted, slept poorly, and took only one-half its usual quantity of food. There was no gastro-intestinal disturbance, but during the week preceding this it had been noticed that the gums about the newly cut teeth were spongy, and showed purple granulations here and there. During the next few days a punctiform purpuric eruption showed itself on the backs of the hands and fingers. On the 16th of September, the child suddenly collapsed, refused food, slept only by fitful naps, and had to be fed a teaspoonful at a time. Exhaustion was marked, the condition alternating between apathy and fretfulness day and night. The

limbs were moved feebly. On the second day of this attack the temperature rose to 101° F. The next day it was 100° ; the next, nearly normal. Coincident with this there was suppression of the urine for eighteen hours, and, for a few times after, the urine stained the diapers a brownish-red. The day before this occurred the child had been moved into another room, as arsenic poisoning was suspected, and the sudden exacerbation of the symptoms occurred on the night of its removal. The papers of both rooms were then tested. That in the room first occupied was found to contain only a small trace of arsenic, and was pronounced to be not a dangerous paper. The paper of the second room into which she had been moved contained a somewhat larger quantity, and was marked "perhaps dangerous." The child was then moved to a neighboring house, the papers of which had been recently tested and found to be free from arsenic. She at once began to improve, and continued to gain, though very gradually. After the second day she sat up and played, was bright, and took more food — though not one-quarter of the regular quantity — and the lips and finger-tips became pink. She continued to grow stronger, and to sleep better.

The rooms in the house she had left were stripped of their papers, and the walls, woodwork, etc., were thoroughly washed. The straw-matting was swept, and wiped with damp cloths, and all hangings and cretonnes, etc., of which there had been but few in the room, were removed. The drainage of the house, which had been found defective, was also put in proper condition, and wholly cut off from the part of the house occupied by the child, and the rooms were thoroughly aired for six days.

After having been absent for six days the child was brought back to the room which she had occupied at first, and which had undergone the treatment described above. No change in her improved condition was noted in the first twenty-four hours, but about twelve hours after this all the former symptoms returned, except the suppression of the urine. The temperature was 101° F. There was no sign of gastro-intestinal disturbance, except a change in the color of the stools to a dark green. She was then taken back to the house which she had just left, and again began to improve slowly, the temperature at the end of the second day being normal. On the following day she was taken to another town, involving a journey of about two hours, which she bore well. Three hours after her arrival, however, there was a recurrence of the collapse; the temperature was 103° F.; the bowels and

stomach became distended with gas; and twelve hours later she died, apparently from heart failure.

The autopsy was made by Dr. W. F. Whitney, who found a profound anæmia of all the organs, moderate enlargement of all the lymphatic glands of the interior of the body, and acute fatty degeneration of the heart. The liver was not fatty. No chemical analysis of the organs was made, and it should be said that the urine had not been examined for arsenic at any time.

All that can be said is, that it is highly improbable that this anæmia, with fatty degeneration of the heart, should have occurred except as a result of pernicious anæmia, or from some toxic cause; that arsenic in toxic dose would be considered a sufficient cause; and that no other was discovered, although the conditions under which the child lived were absolutely under control; finally, that the illness seemed to bear a certain relation to the room with the arsenic paper.

The second collapse which occurred after the child's return to the room, like that in which it finally died, may very well have been purely independent of any new exposure, marking simply a stage in the progress of the disease.

CASE V. The last case is, in brief, that of a physician of this city, who during the greater part of two months suffered from œdema of the face, especially about the eyes, sometimes worse, sometimes better; and from slight pharyngitis, and a slight degree of general malaise. Almost all the wall-papers of his house were found to contain arsenic, and a large trace was found in the urine. No other cause for this œdema was found, and after removal from the exposure, he quickly recovered.

The case was especially interesting because of the accuracy with which the facts could be observed, and also, because the patient, who had formerly given much attention to ornithology, using arsenic largely in curing the skins of birds, had developed a great susceptibility to the poison, so that he had been obliged to abstain from employing it altogether.

It may be added that a similar constitutional susceptibility was also said to be present in the case of the young lady who suffered from the eruption on the face.

Neither of the last three cases were included in the list of analyses reported upon at the beginning of the paper.

